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THE FLORA AND AVIFAUNA OF LADY JULIA PERCY ISLAND, VICTORIA, AUSTRALIA

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ABSTRACT: Unlike most Victorian islands, Lady Julia Percy Island (22 km WSW of Port Fairy) is of volcanic origin. Seals and guano were once harvested on the island which was also stocked briefly; more importantly, rabbits were liberated there. Although the island was originally described as heath or scrub-covered and treeless (as it is today), some later reports are dubious: e.g. a patch of tea-tree reported in 1886. This paper reports on surveys of vegetation and breeding colonies of seabirds made in November 1978 and January 1979 and incorporates unpublished material from other sources.

Four vegetation communities are recognised (grassland, closed-fernland, *Senecio* herbfield, and succulent herbfield) and 100 flowering plants have been recorded. The absence of a shrub-dominated community is striking and may be the consequence of edaphic and biotic factors operating in a harsh environment. The relatively high proportion (35%) of alien species (including many grasses and composites) may be due to human activity and to the unstable conditions present within the areas burrowed by seabirds. The structurally and floristically simple plant communities present little opportunity for colonisation by many passerine bird species and, although the island's list of species is extensive, most records are of isolated migrants or vagrants.

The island provides ample area for breeding seabirds. Of these, the most numerous are the Short-tailed Shearwater *Puffinus tenuirostris*, with a total number of burrows estimated at about 15,300, and the Little Penguin *Eudyptula minor*, with approximately 2,000 burrows. Such estimates are considerably lower than those previously reported by other authors and we consider that other colonies are of more importance for these species. The numbers of Fairy Prion *Pachyptila turtur* and Common Diving-Petrel *Pelecanoides urinatrix* were not estimated and attention should be paid to these two species since their Australian breeding range is centred on Bass Strait, an area for which no reliable population estimates exist.

INTRODUCTION

Most Victorian islands are granitic, isolated from the mainland by sea level changes (see Jennings 1959), but the western Victorian islands, Lady Julia Percy and Lawrence Rocks, are volcanic in origin and may never have been connected with the mainland. Discovered in 1800 (Grant 1803), Lady Julia Percy Island was visited frequently by sealers in the early 19th century. Trigonometric stations were established there in 1840 and 1863, guano was extracted for a time, the island was stocked with pigs and horses between 1879 and 1908 and a hut was erected in 1886 (Mahony 1937). A pair of rabbits was introduced in 1868 (Mahony 1937), and numbers have increased so that they are now a dominant feature of the fauna (Tarr 1954a, b, Prescott 1968).

As part of a study of seabird colonies around the Victorian coast we visited the island in November 1978 and again in January 1979. On both occasions we collected plant specimens and mapped vegetation communities and major sea-bird breeding colonies. Previous literature and unpublished material are reviewed to provide comparative details of the past status of plants, rabbits and bird species on the island.

PHYSICAL FEATURES

Lady Julia Percy Island, with a plateau area of about 129 ha and a total area of 140 ha, lies 5 km off the coast and is some 22 km to the WSW of Port Fairy. The island is relatively low, maximum height about 46 m, and slopes gently upwards from north to south; much of the coastline is of sheer cliffs which are, in

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PLATE 15
Talus slope, Dinghy Cove, Lady Julia Percy Island, January 1979.

places, undermined by wave action. Talus slopes are present, particularly in Dinghy Cove (Pl. 15) and Seal Bay, and basalt platforms are found around the coast.

The island, which was formed during two periods of volcanic activity, is composed of boulder tuff overlain by six lava flows (Stach 1937). Since it is surrounded by deep water (35-45 m), and a vent is present, local volcanic action was apparently responsible for the island's development (Stach 1937). The fine loam soil is generally shallow and includes gravels and ironstone concretions. It is acid (pH 4.8-6.7), with a high organic content, and the poorly developed profiles indicate a very immature soil similar to that of the Stony Rises (Edmonds 1937). Dewhurst (1937), Stach (1937) and Edmonds (1937) provide further details on the island's physiography, geology and soil.

Rainfall at Portland, the nearest mainland weather station, is 782 mm per year, mostly falling between April and November; winds are predominantly from the W in winter, and SW-SE in summer and temperatures are highest in February and lowest in July (Bureau of Meteorology 1975, Land Conservatio Council 1976). The deep waters surrounding it, and its exposure to winds from W round to SE leads to a spray being deposited on the island by most gales (Edmonds 1937).

VEGETATION

In December 1800 Grant (1803) noted that the Island 'was covered with grass but no trees', and Baudin also commented on 1 April 1802 that the Island 'is completely treeless, appears to be covered only with a type of very low-growing heath . . .' (Baudin, 1801-7). According to Mahony (1937) the surveyor Allan reported (in 1862?) that 'the whole island is covered with low, thick scrub, rushes and creepers . . .'. In 1886 there was a patch of dense tea-tree near the southern end, with the rest of the island covered by bracken, grass and rushes (Mahony 1937). By the time of the McCoy Society's visit in 1936 no shrubs were present, nor were they expected since 'the constant high winds, together with the shallowness of the soil on this high and most exposed place, would surely inhibit all such growth' (Edmonds 1937).

In 1936 Edmonds (1937) recognised six communities which are listed below, together with comments summarised from Edmonds. (Specific nomenclature generally follows Willis 1970, 1972, except where modified by Beauglehole 1978a, b. Names used by Edmonds or Patton, 1937 and subsequent collectors have been altered accordingly.)

1. Grassland, which took up about one third of the area; *Agrostis avenacea* predominating, with *Aira caryophyllea* being fairly common, *Briza minor* sparse, and including *Anagallis arvensis* and *Centaurium spicatum*.
2. Fernland, about a third of the island; practically pure, dense, dwarfed *Pteridium esculentum*, with *Agrostis avenacea* in places, and few *Juncus pallidus* and *J. bufonius*.
3. *Senecio lautus*, extensive, mainly on the west; *Agrostis avenacea* and *Carduus tenuiflorus* were also present.
4. Swampland, small area, almost exclusively *Chenopodium glaucum* with *Anagallis arvensis* on edges.
5. *Carpobrotus*, restricted to south, included *Dichondra repens*.
6. Celery, small patch of *Apium prostratum* at southern end.

The distribution of these communities in 1936 is shown in Fig. 1, and the species recorded by Edmonds (1937) and Patton (1937) are given in Appendix I. Tarr (1954a), who visited the island in late 1949, noted that 'with the exception of a few clumps of rushes and a small section of *Mesembryanthemum* [*Carpobrotus*] (pigface) in the south, most of the island was covered with bracken fern, variable groundsel (*Senecio lautus*), a native plant, and a very large extent of the introduced slender shore thistle (*Carduus tenuiflorus*)'. In November 1960, 3 ferns and 85 species of flowering plants, including 29 alien species, were recorded by Beauglehole (1962), who remarked on carpets of stonecrop *Crassula* and trigger-plants *Stylidium*, and the considerable increase in numbers of alien species. Pescott (1965), who visited the island in December 1963, considered that much of the vegetation had been damaged by rabbits. During the same visit G.W.C. collected 66 species, of which 24 (36.4%) were alien. In December 1967 the vegetation was 'classified under four headings — bracken, grass, pigface and *Senecio*' by Pescott (1968), but his accompanying map also showed a small area of rushes. The area covered by bracken had apparently increased since the 1936 survey and *Senecio* had declined. Pescott concluded that the dry conditions which had prevailed in Victoria during 1967 had not affected the bracken and pigface seriously, though the grass, thistles and most of the *Senecio* had died off leaving many acres of bare earth; rabbits were apparently eating pigface roots. In September 1972, vegetation was absent around most of the cliff tops, and severe erosion was occurring (Venn 1972). G.W.C. and A. C. Beauglehole were on the island in December 1974, and collected 82 species of flowering plants of which 29 (35.4%) were aliens.

The vegetation was mapped on 27-30 November 1978 and 23-25 January 1979, using aerial photographs (colour, taken in late December 1978) and ground surveys. Transects were established (Fig. 2) and the percentage cover provided by each species was estimated for each 10 m unit. Four vegetation communities were recognised and their distribution, together with areas of bare ground, are shown in Fig. 1. These communities, similar to those described by Edmonds (1937), were as follows (using Specht's (1970) structural forms):

1. GRASSLAND

Various species of grass (predominantly *Briza minor, Vulpia bromoides, Aira caryophyllea, Agrostis avenacea, Polypogon maritimus* and *Lagurus ovatus*) formed a complex mixed community of varying height. Within the community associated herbs (e.g. *Urtica urens, Polycarpon tetraphyllum, Sagina apetala, Epilobium billardierianum, Anagallis arvensis, Senecio lautus*) were frequently locally dominant. Thistles, mainly *Carduus tenuiflorus* and occasionally *Sonchus asper*, occurred throughout the community and frequently formed dense stands (Pl. 16), particularly in the southern and southwestern section of the community. Such stands reduced the distinction of boundaries with neighbouring communities, especially the fernland. The thistles (*Carduus*), which reached some 0.8 m in height in November 1978, had died back and were broken down by January 1979 and bare earth was increasingly exposed.

Rocks were exposed in some places within the community, but the soil had a maximum depth of some 0.5 m in a few shearwater colonies around the periphery of the grassland. In general plant cover was almost complete, but towards the cliffs both cover and plant height were reduced. Plant heights were also reduced by grazing rabbits, exposure to wind and spray, and trampling by shearwaters.

The grassland community, which now extends along the eastern coast and across the central and southern interior part of the island, has expanded since 1936 (cf. Edmonds 1937 with Fig. 1). It has replaced *Senecio lautus* and *Carpobrotus rossii*, and to a lesser

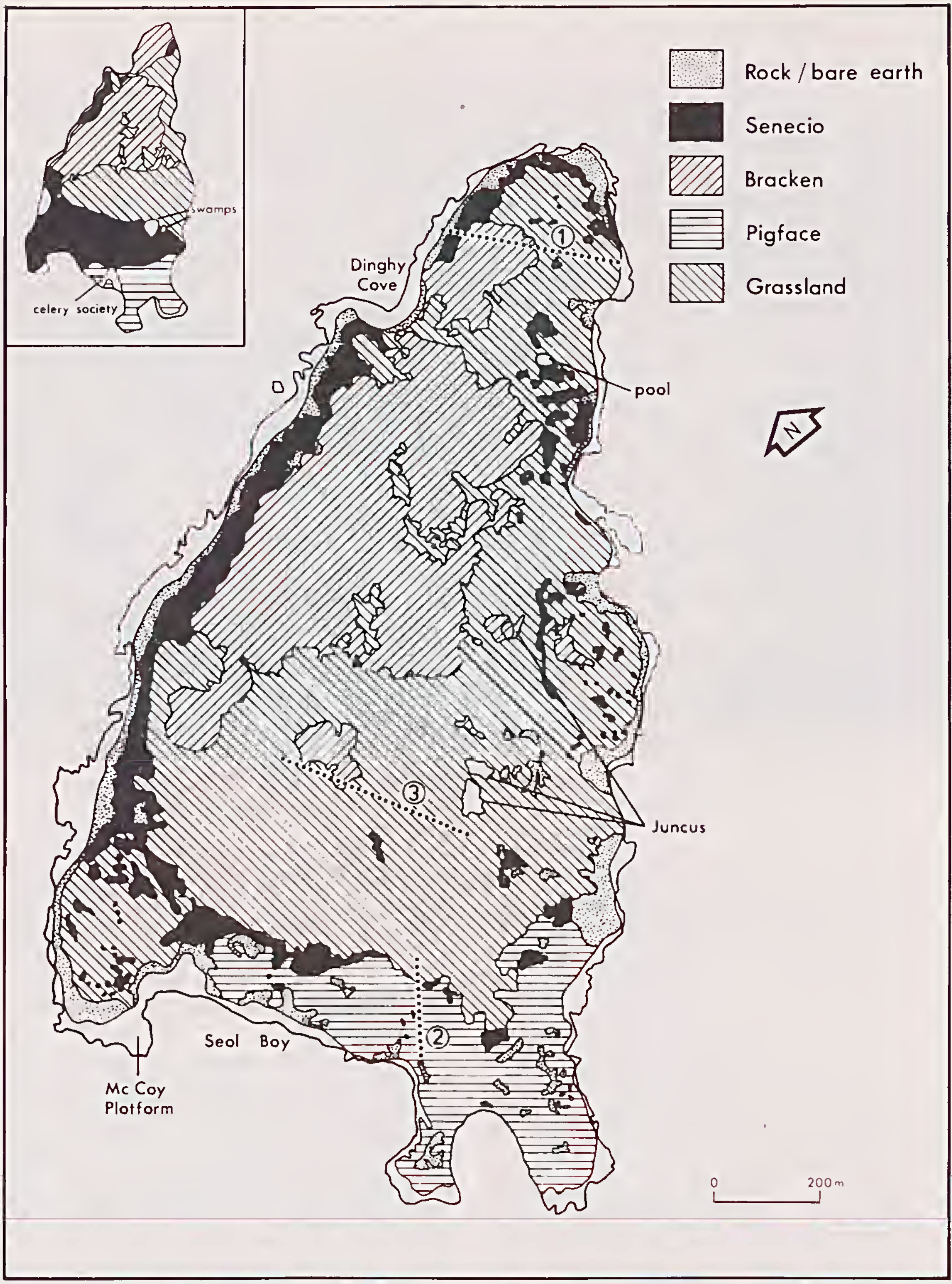

Fig. 1—Major plant communities on Lady Julia Percy Island, November 1978. Inset is a map redrawn from Edmonds (1937) showing community distribution in 1936. (Transect routes used in Fig. 2 are also shown).

PLATE 16
Area of *Carduus tenuiflorus*, southern end of Lady Julia Percy Island, along transect route 2 (on right), November 1978.

extent *Apium prostratum*, on the south and southwest, and fernland on the northeastern edge. During this survey the grassland occupied about 63 ha compared with about 22 ha in 1936 (as determined from Edmonds' map).

2. CLOSED FERNLAND

The shade provided by the dense overlapping fronds of *Pteridium esculentum* (Pl. 17), and the layering of tangled dead plants, has allowed few other species to become established. Although frond height sometimes exceeded 0.8 m, most plants were about 0.5 m and the average height was obviously lower near the coast. In more open areas low ground cover was provided by *Dichelachne crinata*, *Cyperus tenellus*, *Centrolepis strigosa*, *Oxalis corniculata*, *Hydrocotyle hirta*, *Anagallis arvensis*, *Dichondra repens*, and *Cotula australis*. Towards the edges of the community the bracken merged with other species.

There has been some change in the area of fernland since Edmonds' (1937) report (*c.* 20 ha in 1936 compared with about 29.2 ha in November 1978) and the distribution has altered (see Fig. 1). Much of the northern community has been replaced by grassland, and the central portion has advanced slightly though it is not now as extensive as that shown by Pescott (1968). The community has generally retracted from the northern and northeastern cliff edge and advanced along the southwestern edge.

3. *Senecio* HERBFIELD

Senecio lautus (Pl. 18) formed a generally well-defined and robust community occupying relatively shallow soil, on which plants averaged about 0.24 m in January 1979. Often it was the only species present but the cover provided by *Senecio* rarely exceeded 50%; the remainder was bare soil. In a few areas *Vulpia bromoides*, *Agrostis avenacea*, *Polypogon maritimus*, *Anagallis arvensis* and *Carduus tenuiflorus* were associated, being locally dominant or subdominant.

The community covered some 13.4 ha com-

PLATE 17
Pteridium community, northern end of Lady Julia Percy Island looking southeast, November 1978.

pared with approximately 20 ha in 1936 (Edmonds 1937). The southern belt shown by Edmonds has declined whilst a narrow belt of *Senecio* now extends along the west coast. The southern strip shown by Pescott (1968) is now discontinuous, replaced by *Carpobrotus* or grassland, but he did note the occurrence of dead *Senecio* and bare earth on the northern part of the west coast. In 1978-1979 isolated areas on the eastern coast were dominated by *Senecio*, and the species was associated, in part at least, with the distribution of breeding colonies of Short-tailed Shearwaters (cf. Figs. 1 and 3). In January 1979 plants in these areas had been trampled, many had died and were partly broken and covered with soil excavated by shearwaters. In contrast *Senecio* plants outside the bird colonies were still flowering and showing vigorous growth. Plant heights within these colonies were generally higher (0.2- 0.3 m) than those outside, but the plants near cliff tops were usually less than 0.05 m high. Soil depth in *Senecio*-dominated shearwater colonies averaged 0.37 m, whilst in other non-burrowed areas it was considerably less and plants occasionally grew from boulder crevices across bare rock.

4. SUCCULENT HERBFIELD

Generally the succulent *Carpobrotus rossii* formed a dense (to 95%) low cover, particularly on the more exposed south and southwest cliff tops. However, varying amounts of bare earth, exposed pebbles and wind-eroded boulders occurred. Soil depth was minimal throughout most of the community but in shearwater colonies soil depth exceeded 0.35 m. Plants within the colonies were usually taller (0.13-0.25 m) than those outside (0.08- 0.12 m).

Carpobrotus was usually the only species present but in some areas, particularly along the southeastern coast, *Apium prostratum* was locally dominant (sometimes this was the only plant present, covering some 20-30% of otherwise bare earth). These areas were apparently remnants of the more extensive *Apium* community which covered about 3.3 ha in 1936 (Edmonds 1937); *Carpobrotus* had replaced the *Apium*.

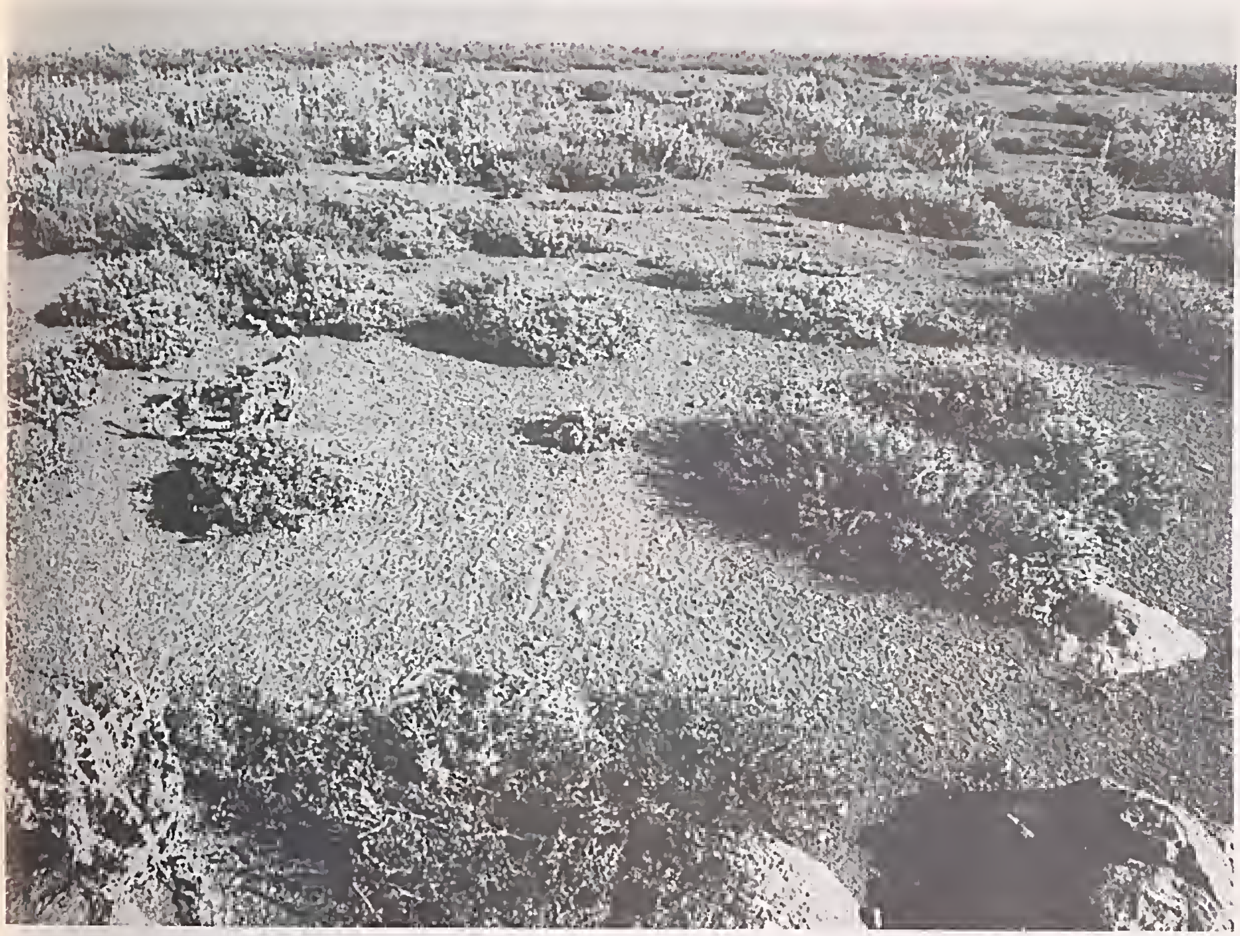

PLATE 18

Senecio community, with exposed soil and boulders, burrowed by Short-tailed Shearwaters and extending into a *Pteridium* community. North-western side, Lady Julia Percy Island, January 1979.

Heights of individual *Apium* plants increased from the cliff edge inland (to about 0.15 m), as did their robustness.

The *Carpobrotus* community, which also included *Anagallis arvensis* and *Senecio lautus*, and occasional *Carduus tenuiflorus*, occupied approximately 14.3 ha in 1978 compared with about 9.4 ha in 1936 (Edmonds 1937), and was more extensive than indicated by Pescott (1968).

The swamp noted by Edmonds (1937) was not recognisable in late 1978, the area being incorporated into the grassland community. However, in November 1978 water filled a depression to the southeast of Dinghy Cove; this was dry in January 1979, and no associated vegetation had developed in the very thin layer of soil overlying bedrock.

GENERAL COMMENTS ON VEGETATION

The vascular plants recorded on Lady Julia Percy Island are listed in Appendix 1. Although most communities recorded by Edmonds (1937) were still recognisable in 1978-1979 their distribution had changed. During the same period there has been an increase in both the numbers of species recorded, and the proportion of aliens included. In 1960, about 31% of the species recorded were aliens (Beauglehole 1962) compared with 23.5% in 1936 (Patton 1937) and the 40% recorded in 1978-1979. There have now been 100 species of flowering plants from 34 families recorded on the island and of these 35 are aliens.

More than a half (19) of the 35 alien species are grasses or composites and their colonisation may well be related to the frequent visits by rabbiters, the possible importation of stock food, and the unstable environment resulting from soil disturbance caused by both rabbits and burrowing seabirds. In addition there could be seed dispersal by wind. The latter may allow temporary invasion by ephemeral species, which rarely become well established, but they, and other species, may be advantaged by variations in seasonal conditions. The depauperate native grass flora (4 of 18), the absence of *Danthonia*, *Stipa teretifolia* and *Poa poiformis* is surprising, since these species are found on other Victorian islands (see Gillham 1960). The few native species of Poaceae may reflect the absence of natural (mammalian) dispersal agents whereas the introduced grasses probably arrived by the agency of man.

Our record of few shrub species present on the island (*Alyxia buxifolia*, *Lycium ferocissimum*, *Solanum laciniatum*) and the restriction of the first two to cliff faces is in contrast with the earlier but inconclusive reports of thick scrub and dense tea-tree (Mahony 1937). Indeed, it is doubtful whether shrub species, other than the three recently recorded, ever existed on the island. In general soils are too fertile, shallow or seasonally dry to allow the extensive development of a tea-tree (*Leptospermum* spp.) community, or to sustain other possible species (called tea-tree by the earlier observers). Opportunities for relict representation on cliff faces are few, since there is little soil and most of the higher reaches, at least, are grazed by rabbits. In general the cliff flora is restricted to *Carpobrotus rossii*, *Salicornia quinqueflora*, *Lepidium foliosum*, *Chenopodium murale*, *Cotula australis*, *Spergularia media*, *Polycarpon tetraphyllum*, *Sonchus asper* and *S. oleraceus*, and *Enchylaena tomentosa*. Vigorous stands of *Asplenium obtusatum* also occur.

Transects taken through the major plant communities are summarized in Fig. 2, where percentage cover for the main species is given for 10 m intervals. Results from the transect indicate the complex nature

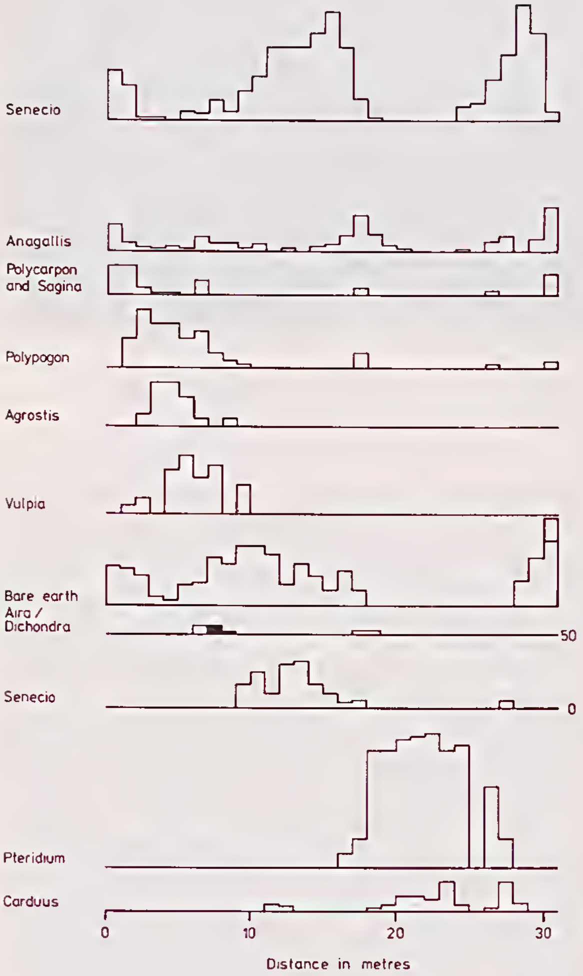

Fig. 2—Line transects (10 m intervals); routes shown in Fig. 1. Transect 1 = 312 m, 2 = 212 m, 3 = 390 m. (Major species only shown). Above, Transect 1.

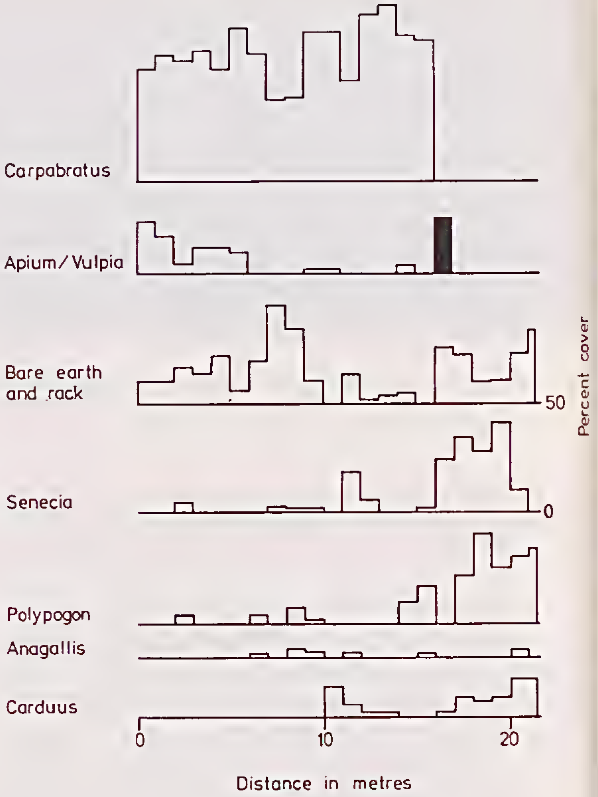

Fig. 2 (*continued*) Transect 2

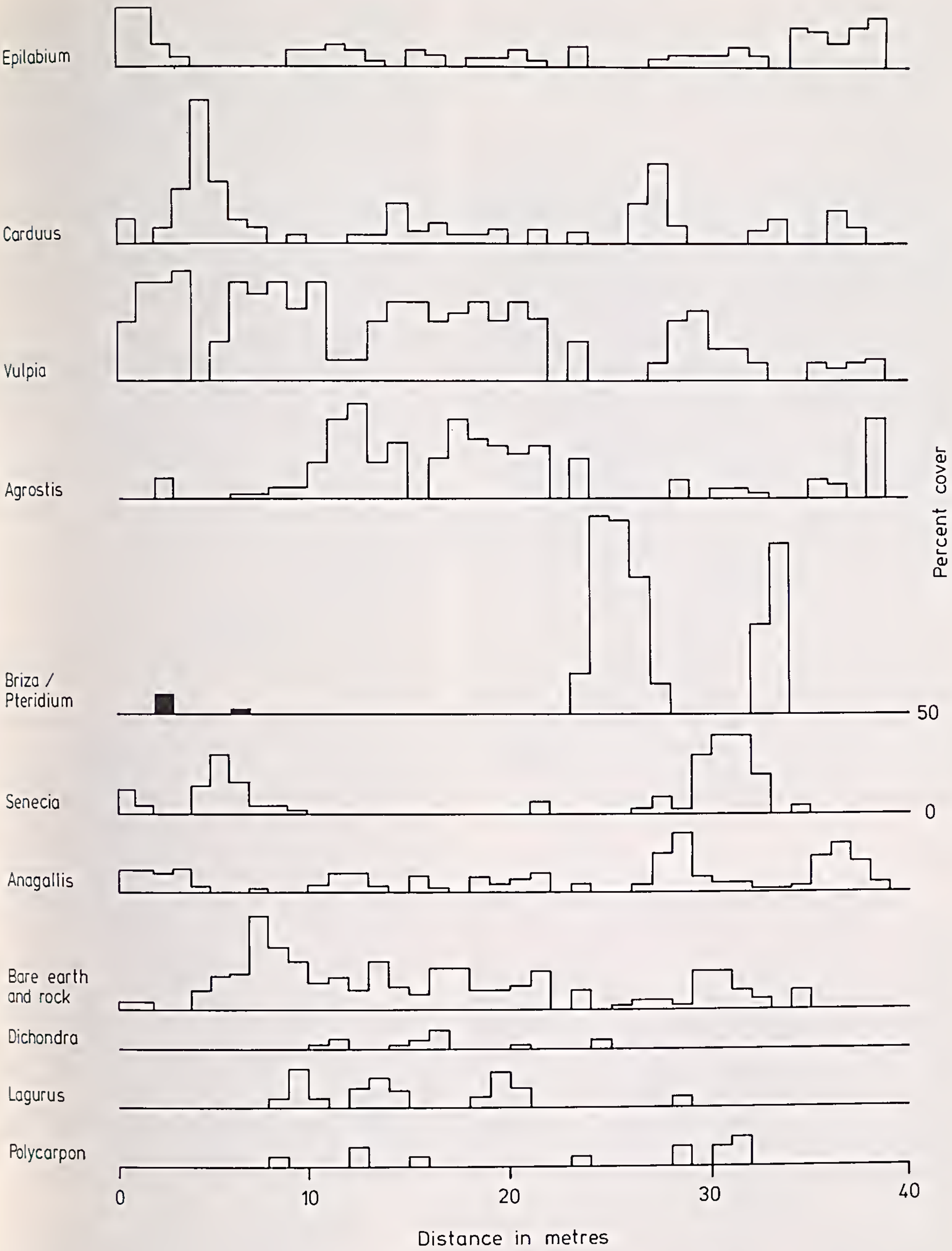

Fig. 2 (*Continued*) Transect 3

of the grassland community, the few plants associated with *Pteridium*, and the frequent occurrence of bare earth or rocks. In November 1978 the area of bare ground was about 9.3 ha.

RABBITS

A pair of rabbits was introduced on to the island in 1868. The species was abundant in 1886 (Mahony 1937) and by 1905 the island was honeycombed with warrens (Ingram 1907). In December 1935, 850 pairs were taken by trappers and the rabbit population was high in January 1936 (Tubb & Brazenor 1937). The island was a 'moving mass' of rabbits in 1936 (Beauglehole 1962), and by 1948 some trappers were taking 4000-6000 rabbits per year (Chappel 1948) and others trapped between 2,500-4,000 in two weeks (Dyson 1948). Rabbits were still numerous in 1949, and trappers caught 1,000 pairs in June (Tarr 1954a). Myxomatosis was present in the late 1950's and extremely few rabbits were seen in November 1960 (Beauglehole 1962), although trappers had introduced more from the mainland (McKean 1961). The rabbits were increasing in 1962 (McKean 1962), and were in 'enormous numbers' by December 1963 when many were dying of starvation, and 'swarms' were existing on pigface (Pescott 1965). Subsequent visitors have recorded large numbers (Venn 1972, Kelly 1976) and the rabbit flea, infected with myxomatosis, was introduced in October 1976. Numbers were still high in January 1979, but dead and dying rabbits (affected by myxomatosis) were found throughout the island.

BIRDS

The restricted number and structure of plant communities present on the island have resulted in relatively few land birds being recorded as resident species. In the summer of 1936, the McCoy Society recorded only three native passerines (Welcome Swallow *Hirundo neoxena*, White-fronted Chat *Epthianura albifrons*, and Richard's Pipit *Anthus novaeseelandiae*), and two introduced (House Sparrow *Passer domesticus*, and Common Starling *Sturnus vulgaris*) (Wood Jones & Tubb 1937). Apart from the breeding seabirds (see below) the Society's list also included Red-capped Plover *Charadrius ruficapillus*, Marsh Harrier *Circus aeruginosus*, Peregrine Falcon *Falco peregrinus*, and Australian Kestrel *F. cenchroides* as other breeding species and Eastern Reef Egret *Egretta sacra* and White-faced Heron *Ardea novaehollandiae* as visitors.

Subsequent observers have recorded the species on the island (see Appendix 2) but added only Black Swan *Cygnus atratus*, Sooty Oystercatcher *Haematopus fuliginosus*, Skylark *Alauda arvensis* and Little Grassbird *Megalurus gramineus* to the list of breeding birds. None of these species were, apparently, present in 1936. Other species have been generally recorded only once, or infrequently. Presumably the paucity of observers, and the restriction of most visits to summer months has also contributed to the reduced total of birds reported from the island, which includes a few trans-Bass Strait migrants.

The populations of seabirds on Lady Julia Percy Island were surveyed in November 1978, and comparison is made below with other recorded details.

LITTLE PENGUIN *Eudyptula minor*

Wood Jones and Tubb (1937) considered that the species breed mainly 'on the west corner of the island', but some were also nesting under talus boulders at Dinghy Cove, Seal Bay and McCoy Platform which appear to be the only landing places for this species. Tarr (1954a) and Pescott (1965) also found breeding penguins at these sites, but noted that they went 'over the top of the island for at least a quarter of a mile'. McKean (1962) considered that the island was the largest nesting area in Victoria with some 5,000-10,000 pairs breeding there. This estimate was repeated in Pescott (1976) but Reilly (1977) considered that there were some 1,260 pairs in Dinghy Cove and Seal Bay.

In 1978 the most obvious and dense penguin colonies were in the talus slopes of Dinghy Cove (234 burrows) and Seal Bay (117). In addition a low-density breeding area was found behind Seal Bay on the headland. This colony, which extends into the westernmost shearwater colony (see Fig. 3), was estimated at 1,600 burrows using mean density and extrapolated area (about 15 ha). A total of about 2,000 penguin burrows was estimated for the island and thus in 1978 both the population size, and the breeding areas, were considerably lower than those indicated by Pescott (1976).

During our visit in November 1978, 49 burrows were checked to provide occupancy data. Of these 22 were empty, 9 had cold deserted eggs, solitary adults were in 7, 4 had an adult with one egg, 3 had an adult and two eggs, and young were present in a further 4. Such data may not, however, be used to provide population estimates since the species has an extended breeding season (Reilly & Balmford 1975).

FAIRY PRION *Pachyptula turtur*

The talus slope boulders in Dinghy Cove were the only breeding sites recorded by Wood Jones and Tubb (1937), and Wood Jones (1937) noted that no prions were 'detected on the island plateau . . . where abundant suitable sites were available'. Wood Jones felt that, whilst the penguin and shearwater might cope with rabbits, the prions could be restricted by them, and therefore nested only under boulders. However, Tarr (1954a) found prions on the east side in burrows on the island's top and, mostly, under pigface. McKean (1962) thought that there were thousands of breeding pairs but Pescott (1976) estimated only some 500 pairs.

No attempt was made to estimate numbers of burrows during our survey..However, the distribution of nests and birds observed (Fig. 3) shows that birds were present, and perhaps nested, in more extensive areas than indicated by Pescott (1976). The species may, indeed, nest around most of the island, though the burrows of this species could not be distinguished from those of the diving-petrel. The island's population, probably thousands, may be one of the larger Australian colonies.

SHORT-TAILED SHEARWATER *Puffinus tenuirostris*

According to Wood Jones and Tubb (1937) there were two large breeding areas in 1936, but Tarr (1954a) considered that the birds nested 'all over [the island], keeping mainly towards the higher edges'. McKean (1962) thought that the island held the largest colony in Victoria, and Wheeler (1965), who stated that nesting areas were found 'right round the island, some extending as far as four hundred yards in from the cliff-tops', considered that 90,000 was a conservative estimate of the number of burrows.

The distribution of burrows found in 1978 is

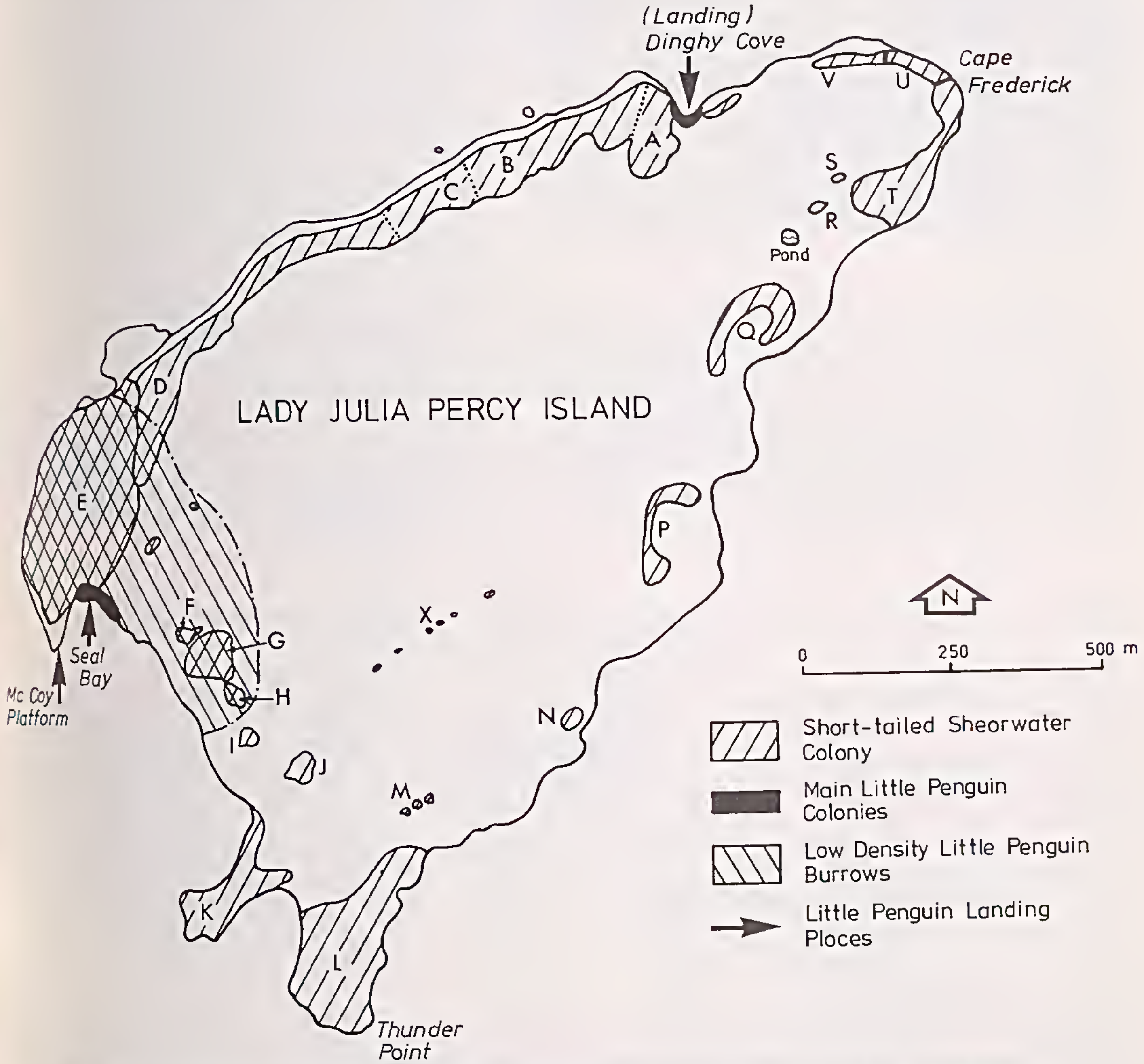

Fig. 3—Distribution of breeding areas of Little Penguin and Short-tailed Shearwater, Lady Julia Percy Island, November 1978.

shown in Fig. 3. Nesting areas did not extend completely around the island, and only on the western corner did burrows extend far inland (A . . . X in Fig. 3). By extrapolation of burrow density, obtained in quadrats of 20 m^2, and direct counts, an estimate of between 13,100 and 17,400 burrows ($p = 0.05$) was obtained for the island (see Table 1). Colonies were more discrete, and less extensive, than those indicated by Pescott (1976).

During our visits many shearwater burrows were found in shallow soil. Many eggs had been laid on the surface, or under patches of *Carpobrotus*: such eggs were deserted, and by January had disappeared.

COMMON DIVING-PETREL *Pelecanoides urinatrix*

Wood Jones and Tubb (1937) found diving-petrels in and around the boulders on the talus slopes of Dinghy Cove and Tarr (1954b) also recorded them in burrows on the top of the island. Pescott (1976) showed an extensive distribution of nesting area for prion and diving-petrel combined, whilst we were able to confirm nesting in five areas in 1978 (see Fig. 4). Diving-petrels were calling in flight, and landing in and around Dinghy Cove in January 1979, even though all young found in December 1978 were near fledging.

DISCUSSION

There are few plant communities on Lady Julia Percy Island, one of the larger Victorian off-shore islands. Though many species of flowering plants have been recorded a shrub flora is absent and, indeed, may never have existed (cf. Grant 1803, Baudin *c.*1801-7, with Mahony 1937). Those conducting the earliest botanical survey of the island (Edmonds 1937, Patton 1937) found no evidence of a shrub community, nor did they expect one. Reports of a tea-tree or scrub may have referred to other woody perennials, rather than *Melaleuca* or *Leptospermum*; either group may have been fired and reduced by sealers, rabbiters, guano workers, aborigines (the island was a totem centre, Massola 1968, Gill & West 1971), or more casual visitors. These, together with rabbits and stock, could have reduced regeneration to the point where no shrub cover was present in 1936 (Edmonds 1937). Several visitors to the island have related severe erosion to increases in the rabbit population, but the interrelationship between the vegetation, breeding seabirds and rabbits has not been studied. (Nor indeed has the local influence of fur seals *Arctocephalus pusillus* on vegetation around and above Seal Bay been examined.) The structurally and floristically simple plant communities now found on Lady Julia Percy presumably reflect the interactions of a relatively harsh environment, edaphic parameters and the biotic influence of grazing, trampling, burrowing and manuring by rabbits, penguins and shearwaters. The volcanic origin of the island may have restricted the range of species colonizing. The success of alien species may have been enhanced by selective grazing by rabbits and the absence of dispersive agents for some of the native species. Additionally, adverse seasonal conditions may modify both the abundance of the plant species and the influence of rabbits on them. Certainly a reduction in the number of rabbits may lead to re-vegetation of an eroded area (and an increase in areas occupied by breeding shearwaters) but vegetation within colonies of shearwaters, and at take-off points, may be temporarily destroyed as a direct consequence of the birds

TABLE 1
ESTIMATES OF NUMBERS OF SHORT-TAILED SHEARWATER BURROWS ON LADY JULIA PERCY ISLAND, NOVEMBER 1978.
(COLONIES LISTED ARE LOCATED IN FIG. 4.)

Colony	Area	No. of 20 m^2 quadrats	Burrow density/m^2		Estimated burrow total	
			Mean	S.E.	Mean	Range
A	0.84	30	0.197	0.016	1650	1380-1920
B.	2.05	30	0.135	0.016	2770	2130-3410
C	0.90	20	0.105	0.013	940	700-1100
D	2.92	30	0.060	0.013	1750	1000-2500
E	6.85	count in 0.17ha	—	—	2165	—
F	0.12	14	0.061	0.013	70	40-110
G	0.56	30	0.167	0.017	940	40-1130
K	1.44	count	—	—	490	—
L	3.61	count	—	—	810	—
T	0.18	25	0.170	0.020	310	230-380
Others		various	—	—	3400	3350-3450
Totals					c.15300	13100-17400

burrowing and trampling (Gillham 1960, 1961, Norman 1970). This destruction, which may allow invasion by ephemerals, may be locally severe and whole colonies of plants may become totally denuded (*Senecio*, for example, dies off completely leaving bare earth). In drought years, and in the presence of rabbits, such areas may become foci for sheet erosion but normally they recover before the next breeding season (Norman 1970).

Edmonds (1937) and Patton (1937) found a relatively high proportion of alien species in the island's flora in 1936, and subsequent collections have shown that this has increased. The lack of tussock-forming species is striking but not attributable to rabbits since the species co-exist with them elsewhere. In the absence of tussock species most shearwater burrows are beneath *Senecio, Carpobrotus* and (mostly alien) grassland. The absence of *Cereopsis novaehollandiae* is also of interest, since the species breeds on islands off Wilsons Promontory (Dorward & Pizzey 1965, Dorward 1967).

The low diversity of life forms shown within the few plant communities present is also reflected by the few non-passerine or passerine species breeding on the island. Although occasional opportunistic nesting may occur (e.g. Black Swan in 1976) it is unlikely that additional species will breed regularly. The populations of breeding seabirds are unlikely to have been affected by either the possible shrub removal or by the introduction of rabbits. No evidence of previous colony areas has been found and the differences in population estimates of seabirds presumably relate to methods used. Further, there are now few unoccupied areas which would support burrows of either penguin or shearwater. For the Little Penguin and Short-tailed Shearwater, the Island certainly does not represent the largest colony in Victoria (cf. McKean 1962) since islands off Wilsons Promontory and Phillip and Gabo Islands individually maintain many more breeding pairs (Harris and Norman in prep). However, the importance of the Fairy Prion and Common Diving-Petrel populations is less certain since reliable estimates are difficult to make. It may be that Lady Julia Percy Island has the largest colonies in Victoria and thus more attention should be paid to these species, since their Australian breeding range is centred on Bass Strait (Serventy, Serventy & Warham 1971). If a rabbit eradication campaign is pursued, changes in the Island's vegetation and seabird colonies should be monitored.

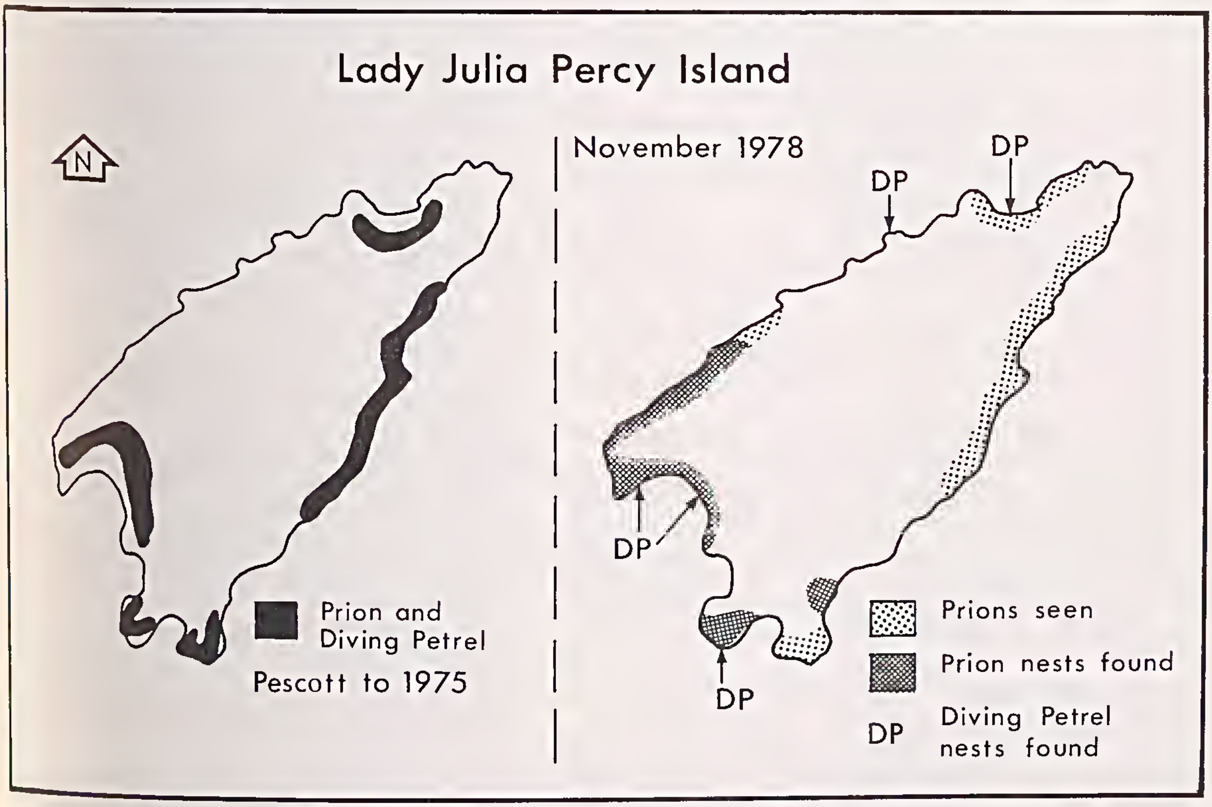

Fig. 4—Distribution of Fairy Prion and Common Diving-Petrel on Lady Julia Percy Island. Comparison is made with an earlier report (Pescott 1976).

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APPENDIX 1.

Plants recorded from Lady Julia Percy Island by Patton, and Edmonds in 1936 (summer); Beauglehole in 1960 (November); Carr in 1964 (December); Beauglehole and Carr in 1974 (December); and in this survey in 1978 (November) and 1979 (January). Specific nomenclature follows Willis (1970, 1972) as modified by Beauglehole (1978 a, b); Raven and Raven (1976), and Simon (1978); species recorded in brackets denotes assigned dubious records and * denotes alien species. Voucher specimens of most species are held at the National Herbarium, Melbourne (MEL) or La Trobe University Herbarium (LTB).

Below 1. Patton/Edmonds, 2. Beauglehole, 3. Carr, 4. Beauglehole & Carr 5. This Survey

	1	2	3	4	5
ASPLENIACEAE					
Asplenium obtusatum Forst.f.	X	X	X	X	X
DENNSTAEDTIACEAE					
Pteridium esculentum (Forst.f.) Nakai	X	X	X	X	X
OPHIOGLOSSACEAE					
Ophioglossum coriaceum A. Cunn. in Hook.		X	X		
CENTROLEPIDACEAE					
Aphelia pumilio F. Muell.		X			
Centrolepis polygyna (R.Br.) Hieron.		X		X	
C. strigosa (R.Br.) Roem & Schult.		X	X	X	X
CYPERACEAE					
Cyperus tenellus L.f.		X	X	X	X
Eleocharis acuta R. Br.		X		X	X
Scirpus cernuus Vahl.		X			X
S. marginatus (Thunb.) J. Raynal		X		X	
S. nodosus Rottb.	X	X	X	X	X
S. platycarpus S. T. Blake		X	X	X	
JUNCACEAE					
Juncus bufonius L.	X	X	X	X	X
J. capitatus Weig.*		X			
J. pallidus R.Br.	X	X	X	X	X
J. ?prismatocarpus R.Br.			X		
JUNCAGINACEAE					
Triglochin centrocarpa Hook.		X		X	
LILIACEAE					
Dianella revoluta R.Br.					X
ORCHIDACEAE					
Microtis unifolia (Forst.f.) Reichenb.		X			
Pterostylis? curta R.Br.			X		
POACEAE					
Agrostic avenacea J.F. Gmel.	X	X	X	X	X
Aira caryophyllea L.*	X	X		X	X
Briza minor L.*	X	X	X	X	X
*Bromus hordeaceus**			X	X	
B. madritensis L.*		X	X	X	X
Dichelachne crinita (L.f.) Hook.f.	X	X	X	X	X
Distichlis distichophylla (Labill.) Fassett			X		X
Holcus lanatus L.*		X	X	X	X
*Hordeum leporinum Link**	X	X	X	X	X
Lagurus ovatus L.*				X	X
Lolium perenne L.*			X		X
Lophochloa cristata (L.) Hylander*		X			
Phalaris minor Retz.*	X	X	X	X	X
Poa annua L.*		X	X	X	X

APPENDIX 1 (*continued*)

	1	2	3	4	5
P. australis sp. agg.	X				
Polypogon maritimus Willd.*		X	X	X	X
Puccinellia stricta (Hook.f.) C. Blom.		X	X	X	X
Vulpia bromoides (L.) S.F. Gray*		X	X	X	X
V. myuros (L.) K.C. Gmel.*			X	X	X
AIZOACEAE					
Carpobrotus rossii (Haw.) Schwantes	X	X	X	X	X
Disphyma clavellatum (Haw.) Chinnock	X		X	X	
APIACEAE					
Apium prostratum Vent.	X	X	X	X	X
Hydrocotyle foveolata Hj. Eichler		X			
H. hirta R.Br.ex A. Rich.		X	X	X	X
APOCYNACEAE					
Alyxia buxifolia R.Br.	X	X	X	X	X
ASTERACEAE					
Calocephalus brownii (Cass.) F. Muell.	X	X	X	X	X
Carduus tenuiflorus Curt.*	X	X	X	X	X
Cirsium vulgare (Savi) Ten.*		X	X	X	X
Cotula australis (Sieber ex Spreng.) Hook.f.		X	X	X	X
C. coronopifolia L.	X	X	X	X	
Gnaphalium gymnocephalum DC.		X	X	X	
G. indutum Hook.f. in Hook.	X				
G. luteo-album L.		X	X	X	X
G. sphaericum Willd.				X	
Leontodon taraxacoides (Vill.) Merat*		X		X	
Senecio lautus Forst.f.ex. Willd.	X	X	X	X	X
Sonchus asper (L.) Hill*		X	X	X	X
S. oleraceus L.*				X	X
BORAGINACEAE					
Myostis australis R.Br.		X	X	X	
BRASSICACEAE					
Lepidium foliosum Desv.	X	X	X	X	X
CAMPANULACEAE					
Wahlenbergia quadrifida (R.Br.) Alph.DC.		X		X	
CARYOPHYLLACEAE					
Cerastium glomeratum Thuill.*		X	X	X	X
Polycarpon tetraphyllum (L.) L.*	X	X	X	X	X
Sagina apetala Ard.	X	X	X	X	
S. procumbens L.		X	X	X	X
Silene gallica L.*		X	X	X	
Spergularia media (L.) C. Presl.		X	X	X	X
S. rubra (L.) J. & C. Presl.	X				
Stellaria media (L.) Cyrillo*		X			
CHENOPODIACEAE					
Chenopodium glaucum L.	X	X	X	X	X
C. murale L.*		X	X	X	X
Enchylaena tomentosa R.Br.	X	X	X	X	X
Rhagodia baccata (Labill.) Moq.	X		X	X	
Salicornia quinqueflora Bung. ex Ung-Stern.	X	X	X	X	X
CONVOLVULACEAE					
Dichondra repens Forst. & Forst.f.	X	X	X	X	X
CRASSULACEAE					
Crassula macrantha (Hook.f.) Diels & Pritzel		X			
C. purpurata (Hook.f.) Domin.		X		X	X
C. sieberana (Schult. & Schult.f.) Druce		X	X	X	

APPENDIX 1 (*continued*)

	1	2	3	4	5
ELATINACEAE					
Elatine gratioloides A. Cunn.		X		X	
FABACEAE					
Trifolium cernuum Brot.*		X	X	X	X
Trigonella ornithopodioides (L.) Lam. & DC.*		X		X	
GENTIANACEAE					
Centaurium spicatum (L.) Fritsh	X	sp.		sp.	X
Cicendia filiformis (L.) Delarbre*		X			
Sebaea ovato (Labill.) R.Br.		X	X	X	
GERANIACEAE					
Erodium cicutarium (L.) L'Herit. ex Ait.*		X			
Geranium solanderi R.C. Carolin		X		X	X
Pelargonium australe Willd.	X	X	X	X	
LOBELIACEAE					
Pratia platycalyx (F. Muell.) Benth.		X		X	
LOGANIACEAE					
Mitrasacme paradoxa R.Br.		X			
ONAGRACEAE					
Epilobium billardierianum Ser. ex.DC.	X	X	X	X	X
OXALIDACEAE					
Oxalis corniculata L.		X	X	X	X
POLYGONACEAE					
Rumex brownii Campd.		X	X	X	X
PRIMULACEAE					
Anagallis arvensis L.*	X	X	X	X	X
Samolus minima (L.) Krause*		X		X	
S. repens (Forst. & Forst.f.)			X	X	
RANUNCULACEAE					
Ranunculus sessiliflorus R.Br. ex DC		X		X	
RUBIACEAE					
Galium murale (L.) All.*		X	X	X	X
SCROPHULARIACEAE					
Limosella australis R.Br.		X		X	X
SOLANACEAE					
Lycium ferocissimum Miers*		X	X	X	X
Solanum laciniatum Ait.	(X)	X	X	X	X
S. nigrum L.*		X	X	X	
STYLIDIACEAE					
Stylidium inundatum R.Br.		X	X	X	
URTICACEAE					
Parietaria debilis Forst.f.		X		X	X
Urtica urens L. *	X	X	X	X	X

APPENDIX 2.

SUMMARY OF BIRDS RECORDED ON LADY JULIA PERCY ISLAND.

(Nomenclature follows Royal Australasian Ornithologists Union 1978. See references.)

Fiordland Penguin *Eudyptes pachyrhynchus*
One moulting bird January 1979.

Erect-creasted Penguin *Eudyptes sclateri*
Recorded from island (Learmonth 1952).

Little Penguin *Eudyptula minor*
Breeding species, population estimated at about 2,000 occupied burrows in 1978. (See above for further details).

Fairy Prion *Pachyptula turtur*
Breeding species, mainly in talus slopes around Dinghy Cove and Seal Bay. Population estimated at 'thousands of pairs' (McKean 1962) or 500 pairs (Pescott 1976), and thousands of pairs in 1978.

Short-tailed Shearwater *Puffinus tenuirostris*
Breeding species, population estimated at between 13,100-17,400 in 1978. (See above for further details).

Common Diving-Petrel *Pelecanoides urinatrix*
Breeding species mainly in talus slopes. 'Comparatively sizeable numbers' (McKean 1962).

Black-faced Shag *Leucocarbo fuscescens*
Infrequently recorded.

Pied Cormorant *Phalacrocorax varius*
Very infrequent visitor.

Little Pied Cormorant *Phalacrocorax melanoleucos*
Very infrequent visitor.

White-faced Heron *Ardea novaehollandiae*
A few birds recorded by most observers.

Eastern Reef Egret *Egretta sacra*
Recorded by Wood Jones and Tubb (1937) but not subsequently.

Black Swan *Cygnus atratus*
Nest recorded in 1976 (P. C. Kelly).

Australian Shelduck *Tadorna tadornoides*
Pair present in July 1970 (R. M. Warneke, Pers. comm.) and in November 1978.

Whistling Kite *Haliastur sphenurus*
Recorded once, by Tarr (1954b).

White-bellied Sea-eagle *Haliaeetus leucogaster*
One seen in January 1978 (K. Norris, *pers. comm.*).

Marsh Harrier *Circus aeruginosus*
Breeding species, with six nests in 1978, and a maximum of 18 birds recorded in 1975 (G. E. Cerini). Feeds on rabbits and shearwaters.

Peregrine Falcon *Falco peregrinus*
Breeding species, maximum of five birds seen (Tarr 1954b), seen feeding on prions and Short-tailed Shearwaters.

Brown Falcon *Falco berigora*
Two birds recorded in 1964 (Wheeler 1965) and in 1978.

Australian Kestrel *Falco cenchoides*
Usually one pair present.

Stubble Quail *Coturnix novaezelandiae*
A few birds recorded in 1949 (Tarr 1954a) and 1964 (Wheeler 1965).

Sooty Oystercatcher *Haematopus fuliginosus*
Two-three pairs breed.

Masked Lapwing *Vanellus miles*
Recorded by Tarr (1954b), and by R. M. Warneke in July 1970 and January 1976.

Red-capped Plover *Charadrius ruficapillus*
Only record, as a breeding species, by Wood Jones and Tubbs (1937).

Black-fronted Plover *Charadrius melanops*
Recorded by A. C. Beauglehole in 1974.

Silver Gull *Larus novaehollandiae*
Frequently recorded (maximum 50) roosting on island.

Pacific Gull *Larus pacificus*
Occasional records.

Arctic Tern *Sterna paradisea*
One found dead on island (Wheeler 1965).

Crested Tern *Sterna bergii*
Occasionally recorded on rocks around island.

Eastern Rosella *Platycercus eximius*
One dead young found in 1964 (Pescott 1965).

Blue-winged Parrot *Neophema chrysostoma*
Recorded by Tarr (1954b).

Fan-tailed Cuckoo *Cacomantis pyrrhophanus*
Seen by Beauglehole in December 1974.

Barn Owl *Tyto alba*
Occasionally recorded, with a maximum of seven in

APPENDIX 2 (*continued*)

July 1970. These have been seen feeding on diving-petrels (R. M. Warneke, Pers. comm.).

Skylark *Alauda arvensis*

Now plentiful and nesting but not recorded by Wood Jones and Tubb (1937).

Richard's Pipit *Anthus novaehollandiae*

A common breeding species.

Welcome Swallow *Hirundo neoxena*

Breeding species using caves for nest sites.

Fairy Martin *Petrochelidon ariel*

Beauglehole recorded this species nesting in small numbers, December 1974.

White-winged Triller *Lalage sueurii*

One male seen in November 1978.

Grey Shrike-Thrush *Colluricincla harmonica*

One seen in November 1978.

Satin Flycatcher *Myiagra cyanoleuca*

A male seen in 1949 (Tarr 1954b).

Little Grassbird *Megalurus gramineus*

First recorded in 1960 by McKean (1961), now is moderately common and presumably breeds.

White-fronted Chat *Ephthianura albifrons*

Breeding species with about 100 present in 1973 and in 1978.

European Goldfinch *Carduelis carduelis*

Occasional birds recorded.

House Sparrow *Passer domesticus*

Small numbers have bred, recorded from Wood Jones and Tubb (1937) onwards.

Common Starling *Sturnus vulgaris*

A breeding species, using cliffs, with counts of 75-100 birds.

Australian Magpie *Gymnorhina tibicen*

Recorded only in July 1970 (R. M. Warneke, Pers. comm.).